ALABAMA PRISON ARTS + EDUCATION PROJECT

THE WARBLER

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Dear Student, Artist, Thinker,

Whenever we think of **radiation**, the imagination may jump to nuclear radiation, the kind that is responsible for nuclear warheads and radiation treatments for cancer. Beyond these dramatic applications, radiation is deeply engrained into the way that we perceive the world, and even the universe. The varieties of naturally-occurring radiation are described by the electromagnetic spectrum. This spectrum comprises energy we can see, along with the heat we feel, and that which we can't immediately perceive with our senses. Medical technology incorporates x-rays and gamma rays to see inside someone's body.

Radiation plays a role in star formation, and as such, is foundational to our universe! The study of radiation is applicable in virtually every subfield of science, including physics, biology, chemistry, and geology. In modern society, we have learned how to harness nuclear radiation, which involves the splitting of atoms (among the smallest units of matter). This process creates massive outputs of energy, and we have nuclear power plants based on these reactions.

Life can struggle to survive in high radiation environments, but some organisms have adapted to thrive in these conditions. All life, to some degree, is dependent on radiation. We wouldn't have a sense of sight if it was not for radiation. The sun's heat and light would not exist, and, as we know, life on Earth is dependent on the sun in some form or another. Plants, the base of the food chain, use solar radiation to fuel growth. Animals rely on energy stored in plants, which – once again – originated as solar radiation. The sun emits infrared radiation which we feel in the form of heat, but it also emits ultraviolet radiation. The ozone layer in our atmosphere helps protect us from its harmful effects, but some still escapes: sunburns are a result of this ultraviolet radiation.

Radiation produces something called a free radical in our cells, which can alter DNA and cause cancers. We also *use* radiation to treat cancer by killing the malignant cells that arise from it. Whether within stars or our cells, the principles of radiation very literally shape our lives. I hope you learn a little bit more about one of the driving forces of our universe as you read this week's edition of *The Warbler*.

Taylor and the APAEP Team

"The process of radiation may be, and is, continuous — at any rate within limits extending to far smaller quantities than the quantum." CHARLES GLOVER BARKLA // British physicist

WORDS INSIDE

FOUND INSIDE "YOU SHOULD KNOW ..."

extremophile | an organism that is able to live in extreme environments

biomimicking | emulating the models, systems, and elements of nature for the purpose of solving complex human problems

ambient | relating to the immediate surroundings

FOUND INSIDE "HOW DO SCIENTISTS FIGURE ..."

half-life | in radioactivity, the interval of time required for one-half of the atomic nuclei of a radioactive sample to decay, or, equivalently, the time interval required for the number of disintegrations per second of a radioactive material to decrease by one-half

luminescence | spontaneous emission of light

respective | belonging or relating separately to each of two or more people or things

HISTORY

Radium Girls

The Women Who Fought for Their Lives in a Killer Workplace

BY DON VAUGHAN | *Britannica* | Accessed October 23, 2021

At the onset of World War I, several factories were established across the United States to produce watches and military dials painted with a material containing radium, a radioactive element that glows in the dark. Hundreds of young women were hired for the well-paying painting jobs because their small hands were well suited for the exacting, detailed work.

Radium had been discovered just 20 years earlier by French physicists Marie Curie and Pierre Curie, and its properties were not well known. Because it had been used successfully in the treatment of cancer, many considered radium a miracle element, and a variety of commercial products were manufactured in which radium was an ingredient, including toothpaste and cosmetics.

The women hired to paint dials came to be known as "ghost girls" because the radium dust to which they were exposed daily made their clothes, hair, and skin literally glow. Many of the women wore their best dresses on the job so the fabric would shine brilliantly when they went dancing after work. Some even applied the paint to their teeth because it gave them radiant smiles.

What's more, the painters ingested the radioactive substance as part of their job. Because some of the watch dials on which they worked were extremely small, they were instructed to use their lips to bring their paint brushes to a fine point. When they asked about radium's safety, they were assured by their managers that they had nothing to worry about.

Of course, that wasn't true. Radium can be extremely dangerous, especially with repeated exposure. Marie Curie suffered radiation burns while handling it, and she eventually died from radiation exposure. Other researchers also perished.

It wasn't long before the "Radium Girls" began to experience the physical ravages of their exposure. Among the first was Amelia ("Mollie") Maggia, who painted watches for the Radium Luminous Materials Corp. (later the United States Radium Corp.) in Orange, New Jersey. Maggia's first symptom was a toothache, which required the removal of the tooth. Soon the tooth next to it also had to be extracted.

The mysterious malady spread throughout Maggia's mouth and lower jaw, which had to be removed, then into other parts of her body. Maggia died on September 12, 1922, of a massive hemorrhage. Doctors were puzzled as to the cause of her condition, and, oddly, they determined that she had died of syphilis.

In growing numbers, other Radium Girls became deathly ill. For two years their employer denied any connection between the girls' deaths and their work, until finally commissioning an independent study of the matter, which concluded that the painters had died from the effects of radium exposure. Refusing to accept the report's findings, the company commissioned additional studies that came to the opposite conclusion, and it decried the girls who had taken ill. The public continued to assume that radium was safe.

In 1925 a pathologist named Harrison Martland developed a test that proved conclusively that radium had poisoned the watch painters by destroying their bodies from the inside. The radium industry tried to discredit Martland's findings, but the Radium Girls themselves fought back. Many knew that their days were numbered, but they wanted to do something to help their colleagues still working with the deadly substance.

Radium Girls, painting with no protection

Image from WikiMedia Common, accessed via medium.com

In 1927 attorney Raymond Berry agreed to accept their case. Many of the watch painters had just months to live and were forced to accept an out-of-court settlement. Still, their experiences made the issue of radium safety a front-page story across the world. But, even then, the United States Radium Corp. denied its role, and women continued to get sick and die. It wasn't until 1938, when a dying radium worker named Catherine Wolfe Donohue successfully sued the Radium Dial Co. over her illness, that the issue was finally settled.

The legacy of the Radium Girls can't be understated. Their case was among the first in which a company was held responsible for the health and safety of its employees, and it led to a variety of reforms as well as to the creation of the U.S. Occupational Safety and Health Administration. ●

Edited for space

BIOLOGY

You Should Know About This Chernobyl Fungus That Eats Radiation

BY CAROLINE DELBERT | *Popular Mechanics* | February 6, 2020

Scientists have discovered that a longtime fungal resident of the Chernobyl complex could actually "eat" radiation. In an upcoming paper, scientists will share the results of growing the fungus on the International Space Station.

Scientists have known about this fungus, and similar extremophile organisms that can thrive on radiation, since at least 2007. The variety found in Chernobyl "can decompose radioactive material such as the hot graphite in the remains of the Chernobyl reactor," *Nature* said in 2007. The fungus grows toward the hottest and most radioactive places, like phototropism but for deadly toxins.

How can this fungus process radiation in this way? Because it has tons of very dark melanin pigment that absorbs radiation and processes it in a harmless way to produce energy. Scientists believe this mechanism could be used to make biomimicking substances that both block radiation from penetrating and turn it into a renewable energy source.

Chernobyl is a special case where extreme ambient radiation is a huge danger to anyone who enters, and having a "radiation blocker" to treat protective suits or even the entire inside of the plant to reduce ambient radiation could be a huge boon. Besides reducing danger, though, the world is filled with machinery and devices that safely use radiation, from medicine to manufacturing. Even low levels of contained radiation could be used to make energy that could reduce the energy burden of those devices.

Kasthuri Venkateswaran, a NASA biotechnologist with over 40 years of research experience, has helmed NASA's research on the radiation extremophile fungus. His publications from over the years include dozens of papers about organisms aboard the International Space Station (ISS), and that's where he plans to take the radiation-eating fungus next.

The ambient radiation aboard the space station is low compared to other parts of space, but it's high compared to the Earth's surface. Growing the fungus there could reveal new sides of its nature, and may confirm that the fungus can still absorb and process radiation in the much more immersed environment of space. This has great potential for future space travel, where deadly amounts of cosmic radiation are one of the big obstacles scientists must navigate in order to safely send people into outer space.

It's not just fungus that eats radiation in this way. The overall family of extremophiles that live on or despite radiation includes both fungi and bacteria, and different species have different mechanisms for absorbing or tolerating radiation. The NIH explains, "[S]ome populations of microorganisms thrive under different types of radiation due to defensive mechanisms provided by primary and secondary metabolic products, i.e., extremolytes and extremozymes."

Each different metabolic product has potential uses in medicine, safety, and manufacturing. Indeed, the general ability of these organisms to thrive in conditions where most organisms break down, mutate, or develop cancers warrants further study across a variety of disciplines. ●

WORD PLAY A Rebus puzzle is a picture representation of a common word or phrase. How the letters/images appear within each box will give you clues to the answer! For example, if you saw the letters "LOOK ULEAP," you could guess that the phrase is "Look before you leap." *Answers are on the last page!*

MATHEMATICS

Sudoku

#171 PUZZLE NO. 6197706

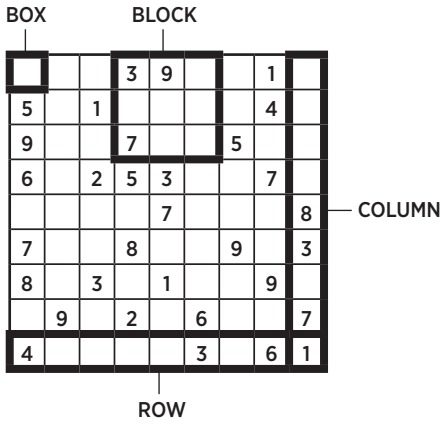
8	1					7		
2						5	4	9
			3	5				
	7	6	8				9	
	5				7			
1				9				6
				1		2		
					3			
6		9						1

#172 PUZZLE NO. 267918

						6	8	
9		3						
		4				1		2
				6	3			
		1		4				
						5		6
1	4		8	5			6	
		9			1	4		7
	3			7				1

SUDOKU HOW-TO GUIDE

1. Each block, row, and column must contain the numbers 1–9.
2. Sudoku is a game of logic and reasoning, so you should not need to guess.
3. Don't repeat numbers within each block, row, or column.
4. Use the process of elimination to figure out the correct placement of numbers in each box.
5. The answers appear on the last page of this newsletter.

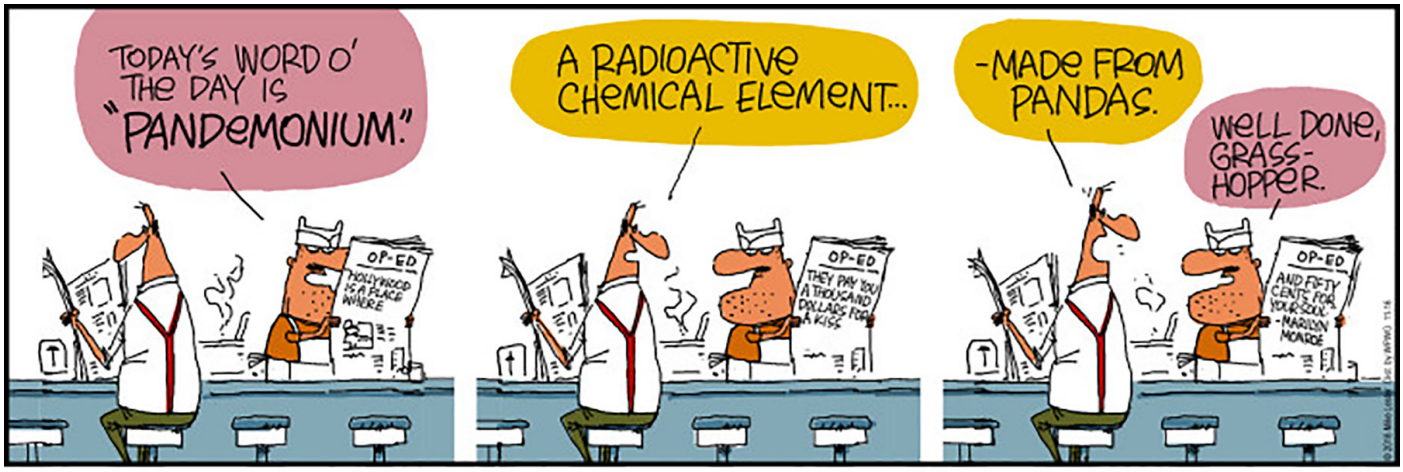


What the example will look like solved

2	**4**	**8**	3	9	**5**	**7**	1	**6**
5	**7**	1	**6**	**2**	**8**	**3**	4	**9**
9	**3**	**6**	7	**4**	**1**	5	**8**	**2**
6	**8**	2	5	3	**9**	**1**	7	**4**
3	**5**	**9**	**1**	7	**4**	**6**	**2**	8
7	**1**	**4**	8	**6**	**2**	9	**5**	3
8	**6**	3	**4**	1	**7**	**2**	9	**5**
1	9	**5**	2	**8**	6	**4**	**3**	7
4	**2**	**7**	**9**	**5**	3	**8**	6	1

"Everything we know about the universe is studied by using telescopes or other instruments that look at visible light, infrared, ultraviolet or X-ray — different wavelengths of electromagnetic interactions. Only 4 percent of what's in the universe gives off electromagnetic radiation, so we don't have any handle on the rest."

BARRY BARISH // American physicist



© Mike Lester

DID YOU KNOW?

Flight attendants and pilots are exposed to so much radiation from flying that they are considered radiation workers. They are exposed to more than many who work at nuclear power plants.

NYC's Grand Central Station was made with a huge amount of **granite**, which emits radiation. There is more radiation in the station than a nuclear power plant would allow.

The **American flags placed on the moon** have faded to white because of the effects of radiation from the sun.

Source: www.softschools.com/facts/energy/radiation_facts/3207/

One of the firefighters who attended the Chernobyl disaster said his **eyes turned blue** from the radiation. They were brown before.

In 2004 a **neutron star** blasted earth with more radiation than ever recorded, from 50,000 light years away.

> "You cannot hope to build a better world without improving the individuals. To that end, each of us must work for his own improvement and, at the same time, share a general responsibility for all humanity, our particular duty being to aid those to whom we think we can be most useful."
>
> **MARIE CURIE** // Polish-French physicist

Etymology

"Radiation"

radiate (verb) | 1610s, "issue or spread in all directions from a point in rays or straight lines," from Latin *radiatus*, past participle of *radiare* "to beam, shine, gleam; make beaming," from radius "beam of light; spoke of a wheel." Meaning "be radiant, give off rays (of light or heat)" is from 1640s. Can be used to say that someone radiates something such as positivity or happiness.

Source: www.etymonline.com/word/radiate

10 BANANAS HAVE THE SAME AMOUNT OF RADIATION AS A HANDFUL OF RAW URANIUM ORE.

PEOPLE EMIT MORE RADIATION THAN THEIR **CELL PHONES** DO.

Icons from the Noun Project

ART + CULTURE

Power

BY ADRIENNE RICH

Living in the earth-deposits of our history

Today a backhoe divulged out of a crumbling flank of earth
one bottle amber perfect a hundred-year-old
cure for fever or melancholy a tonic
for living on this earth in the winters of this climate.

Today I was reading about Marie Curie:
she must have known she suffered from radiation sickness
her body bombarded for years by the element
she had purified
It seems she denied to the end
the source of the cataracts on her eyes
the cracked and suppurating skin of her finger-ends
till she could no longer hold a test-tube or a pencil

She died a famous woman denying
her wounds
denying
her wounds came from the same source as her power.

WRITING PROMPT
In Adrienne Rich's "Power," she details how the famous chemist, Marie Curie, was both destroyed and immortalized because of her research on radioactivity. Think of another instance in which the thing that gives power, also has the ability to wound. Create a piece of writing that reflects this idea of a dual nature.

Adrienne Rich was born in Baltimore, Maryland on May 16, 1929. Her talent for creating immersive, powerful poems was recognized early in her career, being selected by famous poet W. H. Auden to be published in the *Yale Younger Poets* series for her collection, *A Change of World*. She was selected for this award and published her first collection the same year she graduated with her bachelor's degree at Radcliffe college. Her advocacy for the feminist, civil rights, and gay rights movement in the 1960s and 1970s shaped many of her later poems, and her passion for these causes shaped her collection, *Diving into the Wreck*, for which she received the National Book Award in 1974. She died on March 27, 2012, at the age of eighty-two.

Word Search

L	I	E	N	O	E	E	A	E	A	R	T	H	P
K	N	Y	R	O	A	B	S	N	D	E	K	W	B
R	S	P	I	N	C	U	W	A	R	H	A	E	A
L	P	E	B	E	L	E	M	E	N	T	E	K	C
S	E	Y	E	O	A	S	W	M	A	I	T	R	K
R	E	D	A	O	M	O	L	I	C	N	E	P	H
S	R	A	E	E	P	B	O	S	N	C	M	O	O
K	L	P	O	C	B	N	A	E	P	M	D	W	E
I	C	R	E	U	U	N	W	R	A	O	R	O	O
N	A	K	D	C	W	R	D	O	D	K	C	U	A
K	E	I	I	K	E	O	I	T	R	E	N	C	A
B	A	N	E	F	A	S	U	E	E	L	D	M	H
E	N	L	N	O	S	A	E	N	N	E	C	L	D
N	K	N	A	L	F	Y	R	C	D	I	N	E	C

CURIE
WOUND
PENCIL
BACKHOE
BOMBARDED
POWER
ELEMENT
EYES
FLANK
EARTH
SKIN

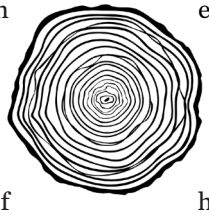
PHYSICS

How Do Scientists Figure Out How Old Things Are?

BY ISOBEL WHITCOMB | Livescience.com | January 10, 2021

The ability to precisely date, or identify the age of an object, can teach us when Earth formed, help reveal past climates and tell us how early humans lived. So how do scientists do it?

Radiocarbon dating is the most common method by far, according to experts. This method involves measuring quantities of carbon-14, a radioactive carbon isotope — or version of an atom with a different number of neutrons. Carbon-14 is ubiquitous in the environment. After it forms high up in the atmosphere, plants breathe it in and animals breathe it out, said Thomas Higham, an archaeologist and radiocarbon dating specialist at the University of Oxford in England. "Everything that's alive takes it up," Higham told *Live Science*.



While the most common form of carbon has six neutrons, carbon-14 has two extra. That makes the isotope heavier and much less stable than the most common carbon form. So after thousands of years, carbon-14 eventually breaks down. One of its neutrons splits into a proton and an electron. While the electron escapes, the proton remains part of the atom. With one less neutron and one more proton, the isotope decays into nitrogen.

When living things die, they stop taking in carbon-14 and the amount that's left in their body starts the slow process of radioactive decay. Scientists know how long it takes for half of a given quantity of carbon-14 to decay — a length of time called a half-life. That allows them to measure the age of an organic piece of matter — whether that's an animal skin or skeleton, ash or a tree ring — by measuring the ratio of carbon-14 to carbon-12 left in it and comparing that quantity to the carbon-14 half-life.

The half-life of carbon-14 is 5,730 years, making it ideal for scientists who want to study the last 50,000 years of history. "That covers basically the really interesting part of human history," Higham said, "the origins of agriculture, the development of civilizations: All these things happened in the radiocarbon period."

However, objects older than that have lost more than 99% of their carbon-14, leaving too little to detect, said Brendan Culleton, an assistant research professor in the Radiocarbon Laboratory at Pennsylvania State University. For older objects, scientists don't use carbon-14 as a measure of age. Instead, they often look to radioactive isotopes of other elements present in the environment.

For the world's oldest objects, *uranium-thorium-lead dating* is the most useful method. "We use it to date the Earth," Higham said. While radiocarbon dating is useful only for materials that were once alive, scientists can use uranium-thorium-lead dating to measure the age of objects such as rocks. In this method, scientists measure the quantity of a variety of different radioactive isotopes, all of which decay into stable forms of lead. These separate chains of decay begin with the breakdown of uranium-238, uranium-235 and thorium-232.

Each of these isotopes has a different half-life, ranging from days to billions of years, according to the Environmental Protection Agency. Just like radiocarbon dating, scientists calculate the ratios between these isotopes, comparing them with their respective half-lives. Using this method, scientists were able to date the oldest rock ever discovered, a 4.4 billion-year-old zircon crystal found in Australia.

Finally, another dating method tells scientists not how old an object is, but when it was last exposed to heat or sunlight. This method, called luminescence dating, is favored by geo-scientists studying changes in landscapes over the last million years — they can use it to discover when a glacier formed or retreated, depositing rocks over a river-basin, Tammy Rittenour, a geologist at Utah State University, told *Live Science*.

When the minerals in these rocks and sediments are buried, they become exposed to the radiation emitted by the sediments around them. This radiation kicks electrons out of their atoms. Some of the electrons fall back down into the atoms, but others get stuck in holes or other defects in the otherwise dense network of atoms around them. It takes a second exposure to heat or sunlight to knock these electrons back to their original positions. That's exactly what scientists do. They expose a sample to light, and as the electrons fall back into the atoms, they emit heat and light, or a luminescent signal.

"The longer that object is buried, the more radiation it's been exposed to," Rittenour said. In essence, long-buried objects exposed to a lot of radiation will have a tremendous amount of electrons knocked out of place, which together will emit a bright light as they return to their atoms, she said. Therefore, the amount of luminescent signal tells scientists how long the object was buried. ●

SCIENCE

Radiation | The Good, The Bad and The Ugly

BY SARAH GEO AND AKARSH KUMAR DASH | AtomsTalk.com | April 23, 2020

Radiation can have both positive healing benefits and horrendously dangerous effects. Some radiation may not affect you at all! And yet, the discourse surrounding this subject is polarizing, with the majority quick to demonize what they don't fully understand. Many people take advantage of this situation, to peddle snake oil or to spread even more misinformation to further their own ends. It is, therefore, important to separate fact from fiction and learn the science behind this very interesting subject.

Wave Radiation and its effect on biology

The most prevalent and common radiation in our lives comes is actually light. As radiation is the emission of energy through space, our entire planet's energy is derived from energy emitted from a singular source: the sun. Forms of energy such as solar, coal, wind owe their origin to the sun. Food wouldn't exist without the sun. So how can we say radiation is all bad? Well, the matter gets complicated when we start to consider some of the components of light.

Electromagnetic spectrum

Radio Waves | Radio waves are **nonionizing** radiation, which means they cannot bring about ionization. They don't have the energy to separate electrons from atoms or molecules. They cannot break chemical bonds and hence don't cause DNA damage.

Radio waves mainly cause heating of the materials. Unlike other non-ionizing radiation which also brings about heating, radio waves are known to penetrate deeper and hence are used in medicine for deep heating of body tissue increasing blood flow, etc. Strong enough radio waves may penetrate the eye and the lens causing **cataracts**.

Microwaves | Microwaves are nonionizing radiation like radio waves and do not have sufficient energy to break chemical bonds and such. Microwaves are present in everyday life as a result of microwave ovens.

The way microwaves work are, the oscillating electric fields of the microwaves cause vibrations in polar molecules of the substance, increasing its temperature. And hence heating it up. Another interesting case occurred during World War II, where people interacting with microwave radiation over long prolonged periods of exposure heard buzzing and clicking sounds. The research identified that this was due to the thermal expansion of parts of the inner ear.

Infrared | Infrared radiation is known as **heat radiation**. Almost all of its primary applications are heat-based. The strong infrared radiation of high intensity may cause blindness and damage the eye.

Visible Light | **Retinal damage** (damage of the eye) might occur due to prolonged exposure to direct sunlight especially when the pupils of the eye dilated. Such a condition presents us when we look at solar eclipses directly.

Ultraviolet | UV plays an important part in the production of Vitamin D in the body. Vitamin D is important for bone health as well as influences the production of serotonin. Serotonin is a chemical in the brain considered to bring about happiness and the general sense of well-being. But, as the age-old adage goes, that too much of something is not good, long exposure to sunlight may cause severe sunburns, as sunlight has UV components in it. Prolonged exposure to sunlight may even cause skin cancer, as the intensity of UV radiation in sunlight is pretty strong.

X-Ray | X-Rays in a sense are not bad in low levels. Taking a typical Diagnostic X-Ray gives us the same amount of ionizing radiation we experience for about 10 days due to background sources.

These low levels are not enough to put you at risk. But at higher doses, the problems start appearing. Being ionizing in nature X-Rays will obviously result in chemical changes, translating to DNA damage and eventually cancer. Pregnant mothers are at the highest risk, as X-Rays are known to cause errors in the development of a child, resulting in deformities and other problems.

Gamma Ray | Gamma Rays are the **bad boys of wave radiation**. Arising from the radioactive decay of atomic nuclei, they are ionizing radiation that is very penetrating and have a lot of energy. Though they are ionizing in nature, they are still less ionizing than alpha and beta particles (something which is dealt with later on in this article).

They cause damage at the cellular level, breaking the DNA literally. Along with alpha and beta particles, gamma rays are truly one of the vicious forms of radiation, leading to radiation poisoning when exposed to high amounts for a very short time. The risks of cancer increase by 2-10%, for people who receive low levels of exposure for longer periods, like nuclear workers,

For duality's sake | Particle Radiation

Just like light, there are a large number of particles that act as energy conduits. Usually, they tend to be a product of nuclear reactions. When talking about nuclear radioactivity, the most common types that are discussed are

"In the Radiation Laboratory we count it a privilege to do everything we can to assist our medical colleagues in the application of these new tools to the problems of human suffering."

ERNEST LAWRENCE // American nuclear scientist

alpha radiation, beta radiation and neutron radiation.

Let us start with alpha radiation, or alpha particles, as it is also called.

Alpha particles are ionizing, that is, they can knock electrons off other atoms due to their speed and the energy they carry. But because of the particle's relatively large size —It's made up of two protons and two neutrons after all — it can be blocked by clothing, paper or even your skin. Since the skin consists of a layer of dead cells, alpha radiation doesn't do much damage on the outside. The danger arises when some of it is ingested, most often in the form of Radon gas, which decays inside to give alpha particles. In this case, alpha particles can ionize molecules in the cells, causing diseases like cancer.

Beta radiation, like alpha, is a high-energy, high-speed particle, in this case, electrons or positrons. It is produced during nuclear decay, for example when Thorium234 decays into Proactinium234. Another similarity to alpha radiation is that beta radiation is also ionizing, albeit not to the degree of alpha.

Many know that neutrons were discovered by **James Chadwick**, a British physicist working in the Cavendish Laboratory, in 1932. The discovery established the nature of the atomic nucleus, and the uncharged nature of the neutron made it an excellent probe to look into the structure of other atomic nuclei. This was a game-changer in the field of atomic physics, and if you've read about the nuclear fission reactors and the reactions that occur over there, you'll understand how it changed history.

In finality

Remember the time when there was a hullabaloo about how cellphones were causing cancer? What about the time we were asked not to heat food in the microwave because, cancer? There is a lot of misunderstanding of how radiation works, and hopefully, this blog helped you navigate that forest a little easier. Keep in mind, radiation can have both good and bad effects. Radiotherapy is used for the treatment of diseases like cancer, and radio tagging is an efficient method to track and study many molecules or cells. In short, radiation in itself can be considered a tool. How we interact with it and how we use it determines if it will give us cancer or if it'll cure us.

One thing to keep in mind is that everything you see around you is radioactive. Bananas, smoke detectors, ceramic tiles, your fancy "glow in the dark" toys, even you are radioactive! The best thing to do if someone tries to talk about the dangers of radiation, is to find out what specific radiation they are talking about, see how dangerous it is, and take the necessary steps to protect yourself from it. Stay safe, stay healthy. ●

RANDOM-NEST

Types of Electromagnetic Waves

FROM DUCKSTERS.COM | ACCESSED OCTOBER 23, 2021

Electromagnetic waves are organized by their wavelengths and frequencies. Below is a list of each type of wave.

Radio waves range from around a foot long to several miles long. They are often used to transmit data via radio, satellites, radar, and computer networks.

Microwaves are measured in centimeters. We use them to cook food, transmit information, and in radar that helps to predict the weather.

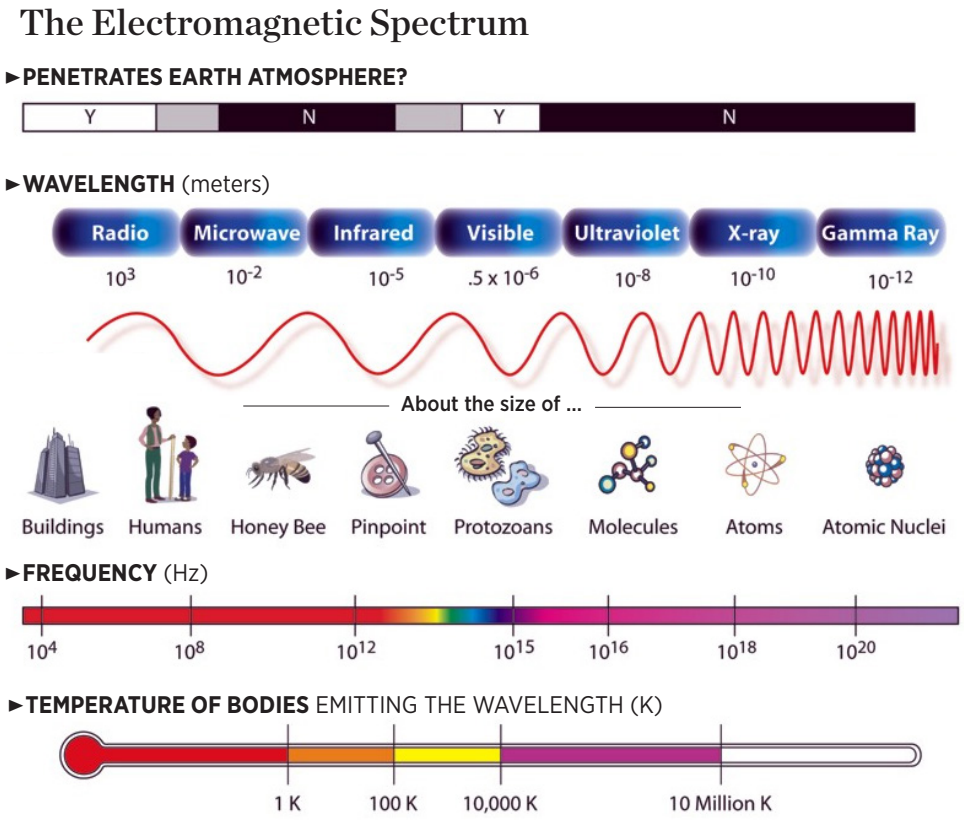
Infrared waves are used in your TV remote to change channels. They also are thermal and give off heat.

The **visible light** spectrum covers the wavelengths that can be seen by the human eye as different colors.

Ultraviolet waves from the sun can cause sunburns, but we are somewhat protected by the ozone layer. Ultraviolet light is used by powerful telescopes to see far away stars.

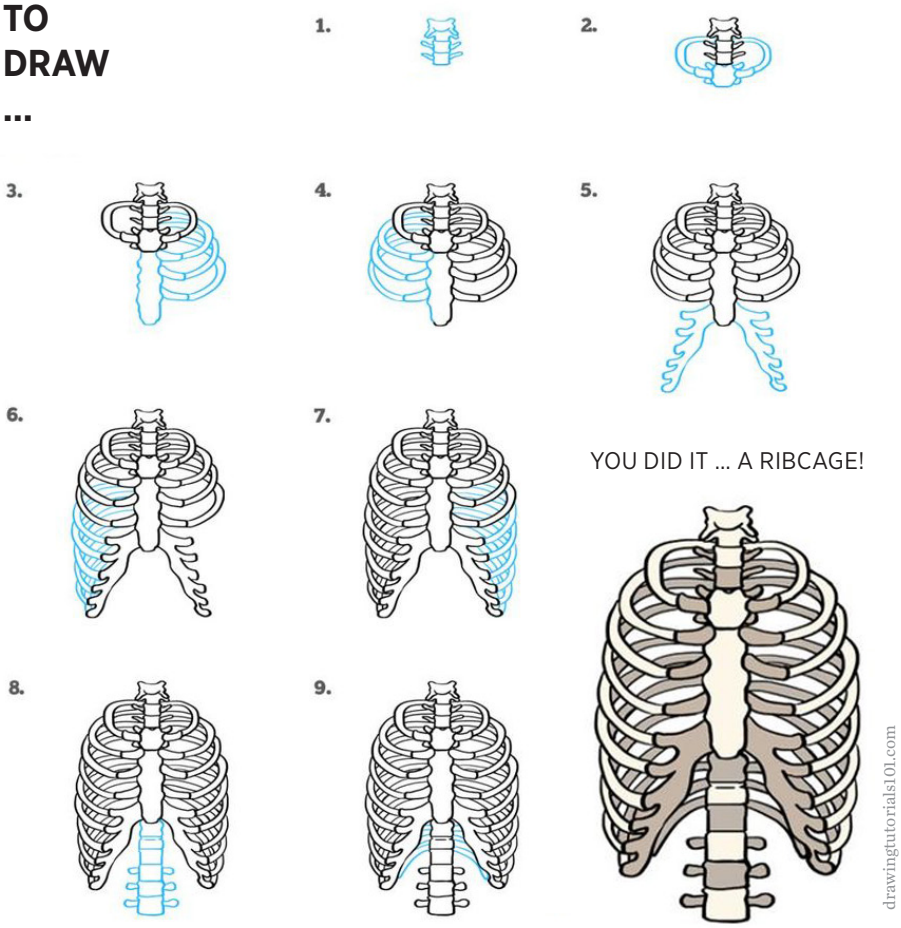
X-rays can be considered to be more like particles than waves. They can penetrate soft tissue like skin and muscle and are used to take X-ray pictures of bones in medicine.

Gamma rays are sometimes used in treating cancer and in taking detailed images for diagnostic medicine. Gamma rays are produced in high energy nuclear explosions and supernovas.



Edited for space and clarity

HOW TO DRAW ...



Words of Encouragement

At first thought, the theme of radiation can seem overtly negative, or even scary. Radioactive elements can be deadly, gamma radiation waves can cause decay to cells. However, while still recognizing its dangers, researchers and doctors have been able to extract so many benefits from radiation. Radiation therapy has been able to help many people diagnosed with cancer; radiation allows X-rays to peek temporarily into our bodies. A phenomena that can be lethal in some contexts can be lifesaving in others.

Probably the most famous early researcher of radiation was Marie Curie, whose work with her husband led her to discover two radioactive elements. Even while the effects were still unknown, Curie once said, "Nothing in life is to be feared, it is only to be understood. Now is the time to understand more so that we may fear less."

With the legacy of Marie and Pierre Curie in mind, we remember to nurture a curious and searching spirit. Stay courageous — and safe! — in your own educational journey. We hope you have enjoyed learning more about radiation in edition of *The Warbler* this week and wish you all the luck in your inquisitive pursuits.

Julia

1061 Beard-Eaves Memorial Coliseum // Auburn University, AL 36849

Answers

SUDOKU #171

8	1	5	4	6	9	7	2	3
2	6	3	1	7	8	5	4	9
4	9	7	3	5	2	6	1	8
3	7	6	8	2	1	4	9	5
9	5	4	6	3	7	1	8	2
1	8	2	5	9	4	3	7	6
7	3	8	9	1	6	2	5	4
5	4	1	2	8	3	9	6	7
6	2	9	7	4	5	8	3	1

SUDOKU #172

2	1	5	4	9	7	6	8	3
9	8	3	1	2	6	7	4	5
6	7	4	3	8	5	1	9	2
7	5	8	2	6	3	9	1	4
3	6	1	5	4	9	2	7	8
4	9	2	7	1	8	5	3	6
1	4	7	8	5	2	3	6	9
8	2	9	6	3	1	4	5	7
5	3	6	9	7	4	8	2	1

Rebus Answers

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1. Short recess
2. Sleeping on the job
3. Slump in the market

Send ideas and comments to:

APAEP
1061 Beard-Eaves
Memorial Coliseum
Auburn University, AL 36849

UNTIL NEXT TIME !